# AIRBORNE BATTLE MANAGEMENT SYSTEM (ABMS)

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## Abstract

The Navy under the Airborne Battle Management System (ABMS) program, sponsored by ONR Code 311 (Command, Control and Combat Systems) and executed by NAVAIR, is addressing the shifting focus of naval operations to power projection in a littoral environment, as expressed in "Forward from the Sea" and "Operational Maneuver from the Sea". To effectively project naval power into the littoral environment with minimal reliance on a heavy footprint ashore, the force will require extensive NCW support from C4ISR located on the "high ground" provided by naval aviation. ABMS specifically addresses the problem of "How to get the right information / image(s) to the right pilot(s) / platform(s) soon enough?" in order to provide Navy and Marine Corps aviation the ability to observe, direct, and control from high above the littoral battlespace. This will be central to our ability to respond quickly and accurately to threats deep inland and to employ ship-launched, air-launched, and ground-launched weapons with maximum effect.

ABMS provides substantial reduction in the engagement timeline for time critical and/or mobile targets through the development of and/or the integration of critical sensor-to-shooter technologies. Specifically, ABMS addresses Continuous Surveillance/Battle Damage Assessment, Information Gathering & Management, Information Dissemination, Target/Combat ID, Multimission Coordination and Deconfliction, Dynamic ROE / ATO and other guidance, Targeting, Target / Weapon Pairing Rate, Precision Fire, Automated Distributed / Decentralized Weaponeering (C2), and Platform Survivability.

ABMS specifically addresses the problem of "How to get the right information / image(s) to the right pilot(s) / platform(s) soon enough?" by shortening the "Decide" phase of both the Detect, Decide, Engage and BDI/BDA Assessment aspects of the kill chain and the OODA (Observe, Orient, Decide, Act) cycle. ABMS is three fold in that it is (1) developing and demonstrating the implementation concepts for intelligent in-flight 4-D (space – time) image management, namely the "Image Editor" (Surveying/"Hot Spot" Detection, Chicleting, IDing, & Filtering), "Router" (Selecting, Geo-Sorting, & Disseminating), and "Sorter" (Time-Sorting/Posting, Geo-Registering to 3-D Terrain Database, and Displaying when Relevant) for bandwidth / timeline reduction, (2) developing and demonstrating Automatic Target Cueing (ATC) and Combat Identification (CID) to recognize 3-D objects (discriminating between targets and friendlies / neutrals) and discriminating between 3-D objects and 2-D decoys, and (3) developing and demonstrating the "plug & play" system integration of a tactical airborne Network Centric information / image battle management and C2 architecture (which includes dynamic ROE, ATO, etc.), geo-registration software tools, various image processing software applications and ABMS' Image Editor/Router/Sorter.

**Background:** Naval aviation represents a unique resource beyond the evident use for sensing and strike. This is an element of the forward force with minimal distance to the enemy, minimal response time to threats (both offensively and defensively); location on a "virtual high ground" that can be as high as Mount Everest, and potential proximity to the enemy that is matched only by ground forces in close combat. Operational commanders have strived for centuries to capture the "high ground" as a location from which to observe, command, and control the battle, and naval aviation offers a significant potential to establish this advantage for our forces.

These advantages are offset by obvious limitations in the ability to support warfighting functions in aircraft that can operate from bases afloat. Limitations include factors such as saturated workload for the pilots and small airborne staffs; limited bandwidth, processing, memory, and display resolution/definition; increased

tempo/rate of change of the battlespace when conflict breaks out; and determining/providing functionally tailored information to the warfighters (what the warfighter needs) when they need it. Other issues include obtaining and integrating off-board and on-board information/images (I2), the need for immediately comprehendible information, "time-late" information, skin-to-skin architectural implications, etc., real-time (RT) node characteristics within the network-centric (NC) architecture for an embedded information management system (IMS) in the platform to manage sharing information (e.g., graphics & imagery, air/ground threats, retasking/replanning) with other forces to support a RT all-source I2 based sensor-to-C2-to-shooter picture of the battlespace, and affordability and retrofit issues (including shortfalls and architectural limitations of legacy aircraft). There is also the need to incorporate the architecture and infrastructure to produce an enterprise wide low latency tactical Single Integrated Battlespace Picture (SIBP). Another major issue is the absence of an integrated "plug & play" tactical airborne Network Centric I2 battle management and C2 architecture for the above critical sensor-to-shooter technologies.

**Discussion:** ABMS addresses these issues by a software development and implementation approach that is coordinated with preplanned software upgrades in the aircraft. One important software enhancement will address the current difficulty that Naval air assets have in sharing images that they collect during their respective missions. This is an important shortfall for time critical strike since tactical aircraft have the potential to share the most tactically relevant and lowest latency I2 and substantially reduce the timeline associated with the detection, decision, engagement and assessment of battle damage. An important technology area that the Airborne Battle Management System addresses is information management and dissemination, namely the processing and management to *automatically* handle the vast amount of data collected, and to *automatically* filter and route the right information to the right operators at the right time. This includes merging of multimedia information as well as fragmenting massive files such as imagery to deliver the part(s) of the images that are relevant to the task.

One is forced to ask (since we can broadcast voice transmissions today): "Why can't we solve the problem of sending the right image to the right platform today?" A brute force approach does not work due to bandwidth overload. Existing demonstrations have essentially been limited to preplanned point-to-point transmissions.

A number of ongoing programs can be brought to bear immediately to provide near term enhancements.

The Advanced Aviation Subsystems (AAS) program, sponsored by ONR Code 35, has developed 3-D visualization technology making direct use of geo-specific databases and image base data. The principle functional product from AAS was used in Kosovo to provide targeting information from UAV video in near real time. It provides the foundation for image exploitation and the Common Tactical Picture (CTP) by accurately geo-registering imagery and presenting it in a wider contextual view. In FY'00 and '01, the visualization and image registration capability will be implemented in embedded avionics processing hardware and then demonstrate these technologies in a time critical strike scenario.

The Real Time Execution Decision Support (REDS) Program was initiated by ONR to provide near real time retargeting capability and to expedite the processing and use of air tasking and air control plans. REDS has produced initial capabilities that are being used and evaluated onboard aircraft carriers and will transition to the future Joint Mission Planning System. REDS also processes the ATO and can deliver parsed, formatted data to the tactical control systems in aircraft such as the E-2C. REDS offers further potential to develop and upload planned route data in minute by minute snapshots for near real time deconfliction and airspace management.

The Automated Rules of Engagement (AROE) program initiated by ONR in FY99 will provide capability to automatically parse and process ROE messages. This will include a dynamic ROE an ATO database that will be linked to the tactical entities in the situation databases and will allow the operators to have a consistent and up-to-date view of the ATO and ROE implications on the threats. AROE offers an opportunity to offload a significant workload from the operators to this automation. Automated agents can provide further assistance by tracking ATO and ROE and providing cues and alerts to the tactical commanders and controllers and also to the higher level commands that are responsible for establishing the ATO and ROE.

Tactical Control System (TCS) is being developed to provide a wide range of control capabilities for unmanned air vehicles (UAVs). An airborne C4ISR control post is clearly a high value location to control low altitude UAVs deep in enemy territory since the links can be direct and relatively wideband and low latency. Proposed enhancements to this system to support time critical strikes will use advanced software to decrease the required footprint and operator-intensive workload and to make the system more amenable to operation onboard tactical aircraft that can operate from afloat bases. This could include both large fixed wing aircraft and VTOL aircraft such as the MV-22 or helicopters.

LARIAT 2, started in FY'00 is integrating the AAS visualization toolset into NAWCAD's Flying testbed, the Hairy Buffalo, and integrating on-board sensors and communication systems with AAS. Since AAS and the DARPA sponsored Warfighter Visualization program focussed on the EO and IR spectrum, LARIAT 2 will principally focus on the accurate registration of SAR imagery. Integration of SAR with highly accurate geo-specific data will provide an all weather strike capability.

The ONR ABMS program was initiated in FY99 to develop/demonstrate an affordable Network Centric (NC) Information Management System (IMS) and battle management / C2 architecture that supports the unique Naval Aviation C4ISR&T requirements for mission planning/replanning and to process/deliver/display RT tactically relevant I2 for RT targeting, air strike, and BDA/I. The integrated technology offers major improvements in time critical targeting, NC IMS, battle management and C2, aircraft survivability, and lethality through the use of advanced information technology to enhance the ability to differentiate targets using existing sensors, to support engagement/weapons release, to shorten the OODA loop, to improve real time situation awareness to avoid pop-up and air threats, to support rapid replanning of strike packages for time critical targets, to decrease fratricide and unintended collateral damage, to deconclict missions in the air and in the objective area on the ground, and to enhance the ability to dominate the battlespace.

ABMS supports the goals and objectives of the Navy Integrated Warfare Architecture (IWAR) by supporting several future Naval enabling capabilities and transition technologies in the areas of information superiority, power projection and air dominance. Furthermore, ABMS directly supports the ONR mission of developing supporting technologies and science and technology programs to provide such future Naval enabling capabilities. ABMS directly supports ONR's recent initiatives in Time Critical Strike while also supporting other ONR initiatives, e.g., Network Centric Warfare, Missile Defense, Autonomous Operations, Information Distribution, Decision Support Systems and Platform Protection. In addition, ABMS supports ONR's mission of supporting several of the emphasis areas identified by Naval Aviation, e.g., Combat ID, ISR & Air-to-Ground Targeting, Network Connectivity, Tactical SA, EW/Defensive CM, Air-to-Ground Weapons, and Total SA.

**Approach:** To resolve the various issues identified above, ABMS is taking a three-fold approach: (1) development, application, and/or implementation of concepts for intelligent 4-D (space – time) in-flight multimedia information management for substantial bandwidth / timeline reduction and improved decision support, including where appropriate the integration of the ground picture with the air picture to create one SIBP; (2) system engineering analysis for implementation and integration of the ABMS concept into appropriate aircraft (E-2C, F/A-18, UAVs, MV-22, Marine Corps helicopters, etc.) to provide tactical airborne Network Centric battle management command and control capability (including determining what software elements are needed / desirable in each platform) and (3) the Phase 2, laboratory demonstrations using simulations and flight demonstrations, to demonstrate the tactical utility of the ABMS concept. ABMS reduces the engagement timeline to minutes by the design, development and integration of its own technology with other existing and/or currently being developed technologies (i.e., AAS, REDS, AROE, TCS, LAIAT 2). Our approach is to develop the implementation concepts for intelligent in-flight 4-D image management through software and perform the system integration of a "plug & play" tactical airborne Network Centric I2 battle management and C2 architecture for time critical sensor-to-shooter technologies. Then demonstrate an architecture that enables shared airborne and surface platform information to Detect, Identify, Decide, Engage/Kill time critical fixed, mobile and moving targets while providing BDI/BDA in

an all weather environment using multiple sensors and multiple existing (and/or new) communications links. The demonstrations will also show the use of that shared information for full SA for air/ground threat avoidance and for replanning consistent with the ATO and ROE. The transition products are (1) basically software upgrades (no new links, no new boxes, but will involve some new wiring) to provide the intelligent in-flight 4-D image management, (2) an integrated "plug & play" tactical airborne Network Centric information / image battle management and C2 architecture, (3) airborne planning/replanning system, (4) theater wide cueing of imaging sensors, (5) automatic decision aids including dynamic ROE and ATO, (6) analysis of ATC/ATR alternatives, (7) analysis and dissemination of offboard land surveillance sensors (UGS), and (8) distributed weapons coordination and collaborative weaponeering of F/A-18s. The intelligent in-flight 4-D image management portion of ABMS is a 6.2 research project and thus involves risk. Hence, in FY99 the "seed" ABMS program was established to mitigate this risk. The proof-of-concept 4-D intelligent algorithm laboratory demonstration in early FY00 was successful in mitigating this risk. Likewise, both the intelligent in-flight 4-D image management portion of ABMS and the integrated "plug & play" tactical airborne Network Centric information / image battle management and C2 architecture leverage other on-going ONR activities to further mitigate risk.

**Description:** ABMS is three fold in that it is (1) developing and demonstrating the implementation concepts for intelligent in-flight 4-D (space – time) image management, namely the "Image Editor" (Surveying/"Hot Spot" Detection, Chicleting, IDing, & Filtering), "Router" (Selecting, Geo-Sorting, & Disseminating), and "Sorter" (Time-Sorting/Posting, Geo-Registering to 3-D Terrain Database, and Displaying when Relevant) for bandwidth / timeline reduction (Figure 1), (2) developing and demonstrating Automatic Target Cueing (ATC) and Combat Identification (CID) to recognize 3-D objects (discriminating between targets and friendlies / neutrals) and discriminating between 3-D objects and 2-D decoys (Figure 2 depicts the ABMS Concept), and (3) developing and demonstrating the "plug & play" system integration of an architecture for tactical airborne Network Centric information / image battle management and C2 (which includes dynamic ROE, ATO, etc.), geo-registration software tools, various image processing software applications and ABMS' Image Editor/Router/Sorter. The ABMS Functional Architecture is depicted in Figure 3 and the Program is depicted below in Figure 4.
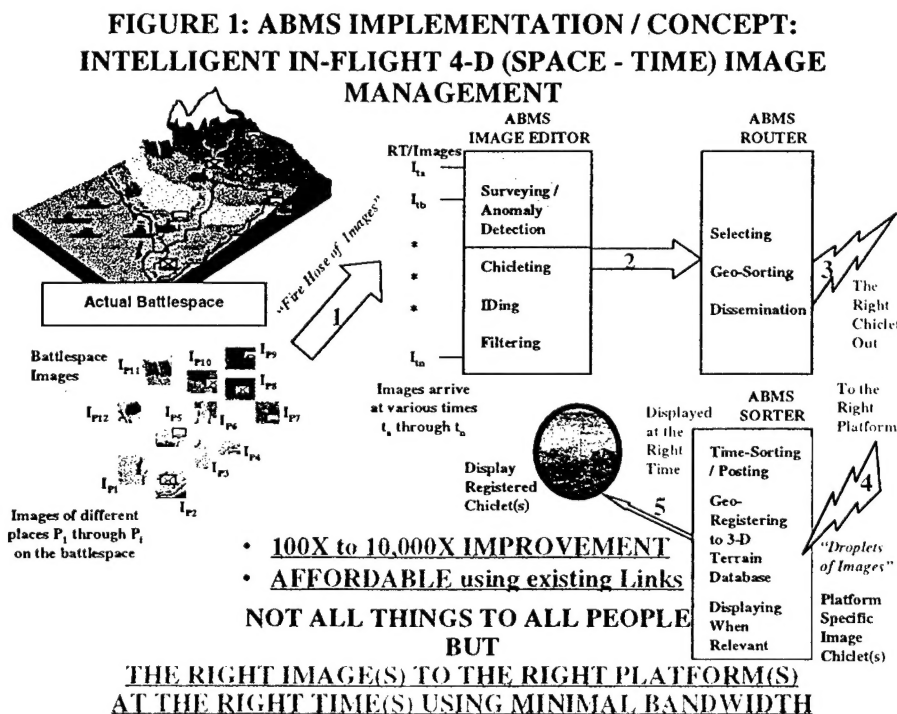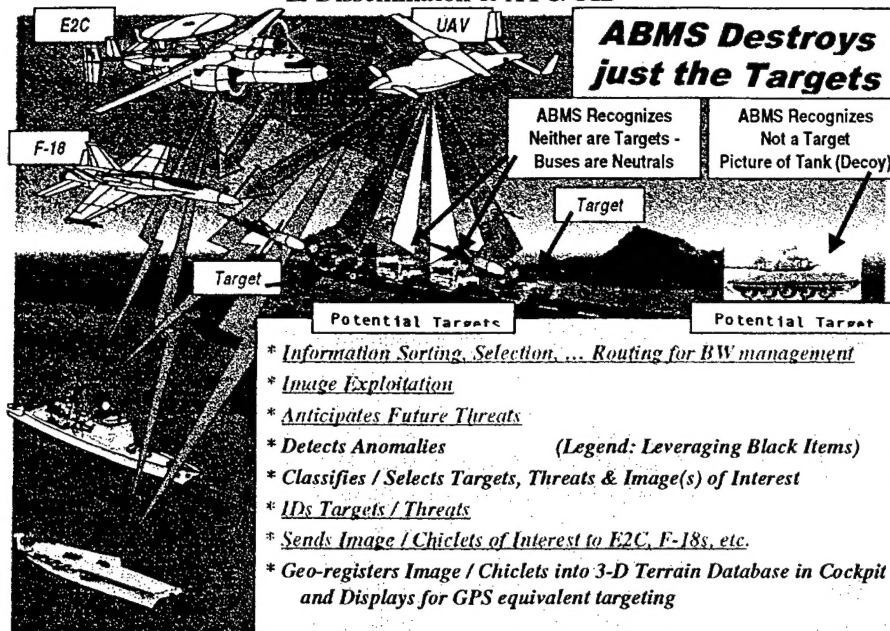
## FIGURE 1: ABMS IMPLEMENTATION / CONCEPT:
## INTELLIGENT IN-FLIGHT 4-D (SPACE - TIME) IMAGE
## MANAGEMENT

## Figure 2 ABMS Concept / Example
### I2 Disseminaton & ATC/CID



**ABMS Destroys just the Targets**

E2C | UAV | F-18

ABMS Recognizes Neither are Targets - Buses are Neutrals

ABMS Recognizes Not a Target Picture of Tank (Decoy)

Target

Target

Potential Targets

Potential Target

* *Information Sorting, Selection, ... Routing for BW management*
* *Image Exploitation*
* *Anticipates Future Threats*
* *Detects Anomalies*       *(Legend: Leveraging Black Items)*
* *Classifies / Selects Targets, Threats & Image(s) of Interest*
* *IDs Targets / Threats*
* *Sends Image / Chiclets of Interest to E2C, F-18s, etc.*
* *Geo-registers Image / Chiclets into 3-D Terrain Database in Cockpit and Displays for GPS equivalent targeting*

## Figure 3
## ABMS' Functional Architecture

Surveillance Assets

Command & Control Assets

Strike Assets

**Detect**
Survey Large Area
Select Regions of Interest

**Decide, Direct & Control**
Classify / ID
Battlespace Awareness
(Dynamic ATO, ROE,
Mission Plan, Actual
Platform Position, etc.)
Information Management &
Dissemination

**Exploit**
Visualization
Image Registration
On-Bd, Off-Bd Sensor
Etc.

# Figure 4 ABMS Program



| CY 2000 | CY 2001 | CY 2002 | ----- | CY 2007 |
|---|---|---|---|---|

**Supporting Efforts**

ONR UCAV Studies; Automated Weaponeering; Advanced Aviation Subsystems; Real-Time Execution Decision Support; Automated Rules of Engagement; Tactical Control Station; etc.

**ABMS System Design**

CONOPS

Candidate Arch

Technology Evaluations and Trades

ABMS Roadmap Dev.

ABMS Transition Planning

**ABMS Integration and Demo**

Iterative Series of System Demonstrations
- Laboratory Experiments
- Joint Simulation Exercises
- Flight Demonstrations

**ABMS Transition**

Image Management Software

Automated Command and Control Software

Display and Attack Functions

*A System Engineering Focused Program which Leverages Existing Technology Developments* = *An ABMS Affordable and Flexible Information Management Infrastructure that Reduces the OODA Cycle Time*
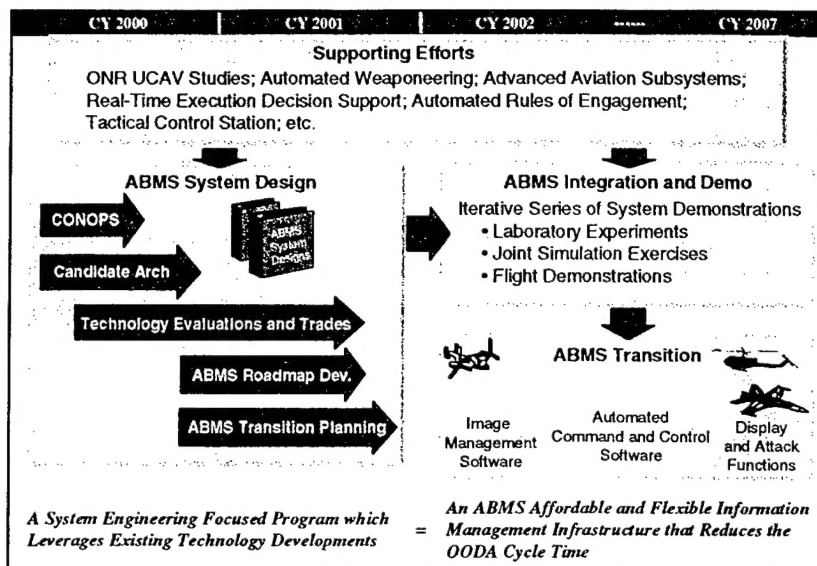
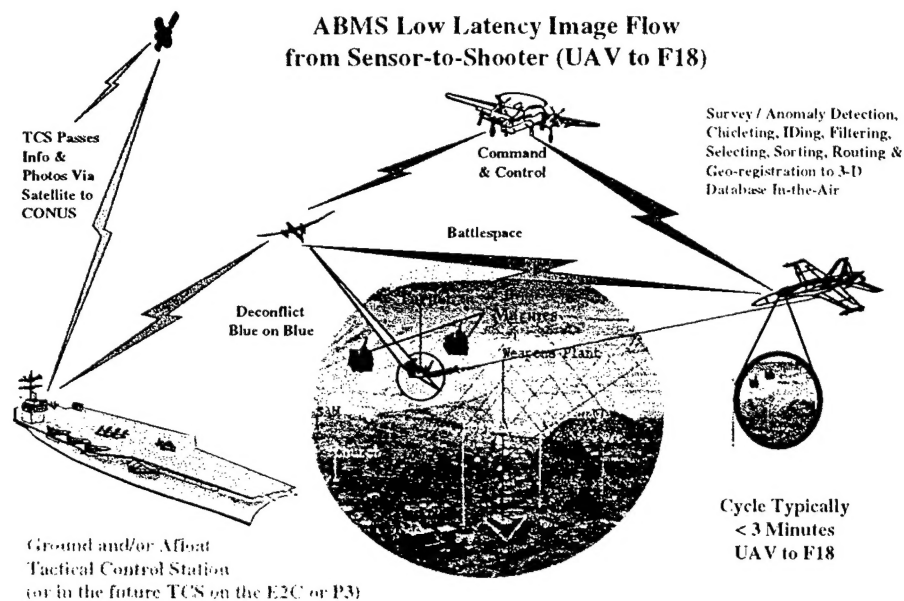ABMS substantial reduces the engagement timeline for time critical and/or mobile targets through the development of and/or the integration of critical sensor-to-shooter technologies. Specifically, ABMS addresses: Continuous Surveillance/Battle Damage Assessment, Information Gathering & Management, Information Dissemination, Deconfliction, Target/Combat ID, Targeting, Target/Weapon Pairing Rate, Precision Fire, Automated Distributed/ Decentralized Weaponeering (C2), and Platform Survivability.

Time Critical Strike (TCS) requires the capability to quickly transfer critical information among the various military forces. Even more important, however, is that the information which is passed be relevant to the mission and that this relevance be made abundantly clear to the warfighter. Therefore, our methodology is to handle both the flow of critical information with its relevance and integrate this into the "plug & play" tactical airborne Network Centric information / image battle management and C2 system. Figure 5 depicts the ABMS low latency I2 flow and real-time execution control.
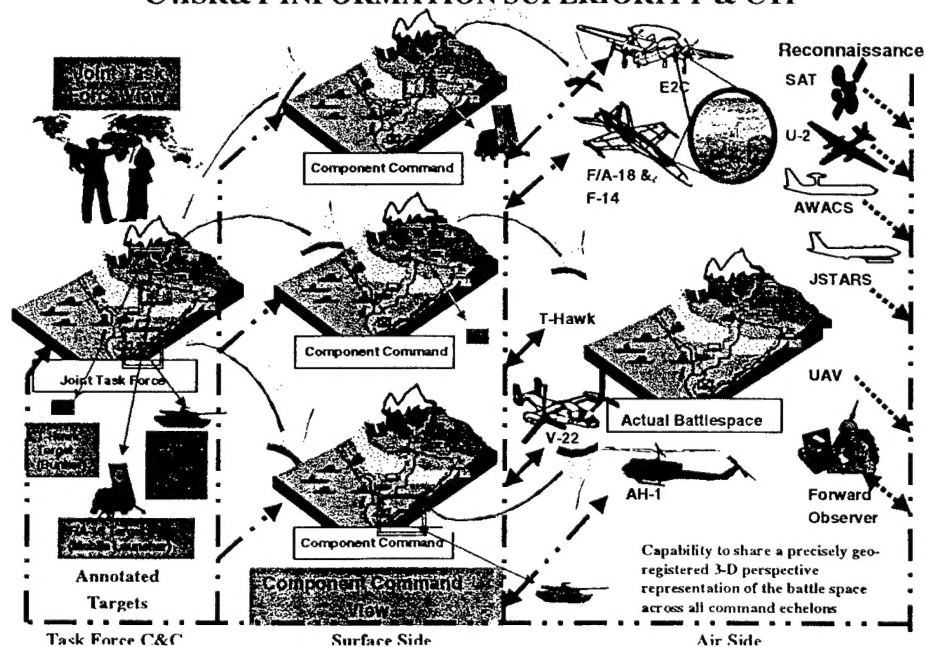
Through the "Image Editor", "Router" and "Sorter" of the intelligent in-flight 4-D image management subsystem, the ATC / CID software and the in-flight, in-theater integrated "plug & play" tactical airborne Network Centric information / image battle management and C2 system the time critical targeting timelines are reduced and targeting accuracy is increased. Information will automatically be routed through the intelligent network and directed to those warfighters with an operational need for it. The information will then be presented in a manner tailored to the warfighter's needs. Since only a small portion of the information is likely to be relevant to individual warfighting components, the actual information / image flow necessary to accomplish this is much smaller than might be imagined. The quantitative benefit is a 100X to 10,000X improvement in the bandwidth / timeline to pass the image chiclets to the image analysts and / or warfighters. ABMS is an affordable solution in that it utilizes existing Data Links to provide an

## Figure 5: ABMS LOW LATENCY INFORMATION/IMAGE FLOW AND REAL-TIME EXECUTION CONTROL

**ABMS Low Latency Image Flow from Sensor-to-Shooter (UAV to F18)**

TCS Passes Info & Photos Via Satellite to CONUS

Command & Control

Survey / Anomaly Detection, Chicleting, IDing, Filtering, Selecting, Sorting, Routing & Geo-registration to 3-D Database In-the-Air

Battlespace

Deconflict Blue on Blue

Cycle Typically < 3 Minutes UAV to F18

Ground and/or Afloat Tactical Control Station (or in the future TCS on the E2C or P3)

integrated tactical airborne Network Centric information / image battle management and C2 system which can provide one meter targeting accuracy through the use of a 3-D Digital Terrain Elevation Database. Figure 6 depicts our global vision of the Network Centric C4ISR&T Information Superiority Architecture and the CTP / COP – SIBP.

## Figure 6: GLOBAL VISION - NETWORK CENTRIC C4ISR&T INFORMATION SUPERIORITY & CTP

Reconnaissance
SAT
E2C
U-2
Component Command
F/A-18 & F-14
AWACS
JSTARS
T-Hawk
Joint Task Force
UAV
Component Command
Actual Battlespace
V-22
AH-1
Forward Observer
Component Command
Annotated Targets
Capability to share a precisely geo-registered 3-D perspective representation of the battle space across all command echelons
Component Command View
Task Force C&C
Surface Side
Air Side

To solve these problems we were forced into a new paradigm, i.e. a "smart" approach that necessitates (1) innovative, intelligent RT 4-D (space-time) image management utilizing logic, down-selection,

determination of applicable user(s) and intelligent Image Editing, Routing, and Sorting. ABMS reduces the engagement timeline to minutes by this new paradigm and leveraging of other existing and/or current developing technologies. Our approach is to develop the implementation concepts for intelligent in-flight 4-D image management and ATC / CID through software. ABMS performs the system integration of a "plug & play" tactical airborne Network Centric information / image battle management and C2 architecture for time critical sensor-to-shooter technologies.

**Payoff:** The ABMS expected payoffs are: (a) Timely processing of images (e.g. selects, filters, shares, routes, delivers, geo-registers) and display of low latency tactically relevant images for real-time targeting, air strike, BDI / BDA and (total and tactical) situation awareness (SA) for a Common Tactical / Operational Picture (CTP / COP) and time critical targeting; (b) ATC / CID, (c) Handles both the flow of critical information and its relevance as well as managing the available limited network bandwidth (BW); (d) Shrinks the OODA cycle time by moving tactical functions from the rear-base to airborne platforms; (e) Provides GPS equivalent targeting through geo-registration of high quality image chiclets into a Digital Terrain Elevation Data (DTED) type 3-D data base; (f) Supports mission planning / replanning; (g) Anticipates threats (warning the pilots and decluttering cockpit displays), and (h) Provides an integrated "plug & play" tactical airborne Network Centric information / image battle management and C2 system for time critical targeting. In short, ABMS will ensure that the right information gets delivered to the right air platform at the right time and is presented / displayed when relevant.

**Summary:** ABMS will provide tactical flexibility through the implementation of technologies that will accelerate the transfer of useful information to the tactical warfighter and will integrate leveraging technologies to address existing shortfalls to improve the warfighers ability to prosecute re-locatable non-emitting targets (TBM, TEL, CCM), short dwell mobile intermittently emitting targets (TAC, SAM, IADS), and moving targets (tanks, APV, trucks). ABMS will provide the ability to discriminate between tanks, trucks, friendlies, neutrals and 2-D decoys. With 80% of the target set mobile / re-locatable, ABMS will improve the Warfighter's reaction time by dynamically assessing the changed battlespace. ABMS will provide an affordable information manage and disseminate system that selects, processes and delivers the right information / images to the right platform at the right time and displays / presents it when relevant, shrinks the OODA loop cycle time, and provides a CTP / COP – a SIBP.

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**14. ABSTRACT**

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